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GAS THAT DEFIES GRAVITY

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Clifford W. Seibel, a young bespectacled scientist at the U. S. Bureau of Mines, in describing the properties of helium gas at a 1917 meeting of the American Society of Chemical Engineers, concluded by stating, "I'm sorry, gentlemen, but there is no practical use for this knowledge." Today Dr. Seibel, internationally known to scientists and industrialists as "Mr. Helium," is virtual czar over our government's research and production of this versatile gas that is now so indispensable to our national defense and outer-space programs. As assistant director of the Bureau of Mines, Dr. Seibel is both gratified and disturbed about the many remarkable developments (many his own) which flatly contradict his early opinion concerning the usefulness of helium. He is, of course, delighted that the gas is such a vital commodity in so many applications; but he is also disturbed that it is in such short supply. Scarcely had Dr. Seibel lamented the practical uselessness of helium during World War I than Sir William Ramsay, discoverer of the gas in the earth's atmosphere, requested the U. S. government to supply helium to inflate blimps of the British North Sea Fleet. Heretofore these lighter-than-air craft had been filled with flammable hydrogen gas which exploded disastrously when hit by tracer bullets from German fighter planes. (An entertaining experiment that demonstrates the marked difference in the density of air and helium consists in having a person inhale a deep breath of helium and then talk. Bassos sound like tenors, and gruff men speak like boys in short pants.)

Although helium has 92.5 percent of the lifting power of hydrogen and is non-flammable, Dr. Seibel was skeptical of the Ramsay project because of seemingly prohibitive production costs. However, he again energetically proceeded to disprove his doubts by devising production methods which supplied this safe inert gas to our ally at a cost of 44 cents per cubic foot--not cheap but within limits. Output increased so rapidly that at the time of the armistice in 1918, 140,000 cubic feet of the gas in cylinders lay stacked on our docks awaiting shipment. Between the two world wars many interesting small-scale applications were discovered for helium. Divers and workmen engaged in tunneling under rivers and harbors commonly experience a painful pathological condition known as caisson disease or the "bends." This affliction is caused by nitrogen in the breathing mixture dissolving in the blood of workers exposed to high pressures. When these men return to normal atmospheric pressure the solubility of the nitrogen in the bloodstream decreases whereupon tiny bubbles escape, thereby producing an excruciating sensation which can be fatal.

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This danger has been lessened by supplying workers a compressed helium-oxygen mixture while they are subjected to high external pressures. Then when they surface, the men are placed in decompression chambers filled with a mixture of helium and oxygen, and pressure is gradually reduced to normal. The advantage of using helium for this purpose is its low solubility in the blood, reducing the tendency of the gas to "bubble out" when a diver or tunneler surfaces. Mixtures of helium and oxygen also have proved successful in treating respiratory diseases such as asthma. Here the lightness and rapid diffusion of helium lessens the muscular effort involved in breathing. Despite Britain's sad experience with hydrogen-filled blimps in World War I, hydrogen continued to be used in dirigibles until the German dirigible Hindenburg exploded at Lakehurst, New Jersey, on May 6, 1937, and killed 36 persons. Since that tragedy, helium has supplanted hydrogen in blimps and ballons. During World War II helium filled our dirigibles which proved so effective in spotting and destroying German submarines.

Helium also found extensive use in World War II as a protective atmosphere for the arc-welding of magnesium alloys. This active metal readily combines with oxygen and nitrogen when welded in air. But blanketing the operation in helium overcame this problem so successfully and conveniently that aluminum and other metals are now welded in an inert atmosphere of helium. After the war helium consumption dropped to 67 million cubic feet by 1948. Some plants shut down as surplus gas was stored under an impermeable dome in a gas field near Amarillo, Texas--center of the nation's helium supply. Within a 250-mile radius of the Cliffside Field near Amarillo exists 99 percent of the free world's supply of helium. Fortunately, this country, whose helium resources are controlled by the federal government, is the only nation known to possess large supplies of this gas. With the advent of the space and missile age helium once again is bursting into full-scale production. This year consumption is expected to zoom to 470 million cubic feet in the U. S., and future needs indicate even larger volumes. Why is helium so vital to defense and outer-space exploration? One reason is that the light alloys for jet planes and rockets must be welded in an inert helium atmosphere. Similarly, helium is required to produce titanium and zirconium from their ores. These "wonder metals" in the molten state tend to absorb gases from the air. If these gaseous contaminants are not carefully controlled, the metals become brittle at ordinary temperatures, thus rendering them useless for structural purposes. Even minute traces of hydrogen have caused unpredictable rupturing and cracking of titanium sheets. This difficulty is hurdled by smothering the molten metal with helium during production so as to crowd out the impurities. Helium is ideally suited for this job as it has no tendency to combine with the metals. Titanium's unique combination of strength, lightness, high melting point and resistance to corrosion makes it invaluable as a structural material in jet engines, missiles and rockets.

Zirconium also is highly resistant to corrosion, and, in addition, it has a very low tendency to absorb neutrons--the "bullets" used in atomic energy installations. This latter property is responsible for the rapid development of zirconium as a shielding structural material in nuclear reactors. Within ten years the price of this metal dropped from $300 to less than $15 per pound.

In liquid form helium is further extending the scope of its useful applications. Because of its extremely low boiling point (only 7 degrees Fahrenheit above absolute zero), helium was the last of the gases to be liquefied. But this extremely low temperature of liquid helium makes it especially useful in refrigerating other gases including liquid oxygen and liquid hydrogen which are extremely useful in powering rockets. Liquid helium is also employed to refrigerate metals used in complex electronic equipment. In common with some metals, liquid helium exhibits electrical superconductivity at temperatures approaching absolute zero (-459 degrees Fahrenheit). This property offers promise in amplification circuits. Intriguing but as yet only of academic interest is the ability of liquid helium to creep through holes in containers impermeable to all other liquids, as well as to be able to defy gravity by scaling the walls of a vessel. In view of helium's important role in solving problems associated with the exploration of outer space, it is appropriate that the gas should first be discovered not on the earth but in the sun's atmosphere. In 1868 the French astronomer Janssen traveled to India where he studied a total eclipse of the sun using a spectroscope. In the spectrum of the sun's corona he noted among familiar bright lines a new yellow line not previously observed with any of the then known elements. This discovery led Sir Norman Lockyer to conclude that the new yellow line was produced by an element on the sun which had not yet been observed on the earth. He named the substance helium from the Greek work "helios" meaning "the sun." A quarter of a century later, Sir William Ramsay and Lord Rayleigh succeeded in isolating an exceedingly rare gas from the atmosphere. This substance produced the same yellow line in the spectrum as that observed from helium in the sun's atmosphere. The English scientists concluded that the two were identical. Helium in the earth's atmosphere was subsequently found to belong to a group of six colorless, odorless, tasteless gases known collectively as the inert gases becauses of their extreme chemical unsociability. Neon gas, which is widely used in bright red electric signs, is a familiar member of this chemical family.

As helium is present in the air to the extent of only one part in about 200,000, other sources of helium had to be exploited for sizable quantities. In this country helium is obtained commercially from the natural gas of Texas wells containing 1 to 2 percent of helium. The methane, nitrogen and other gases associated with the helium are liquefied by cooling under pressure leaving about 98 percent pure helium gas. Further purification is accomplished by passing the gas through activated cocoanut charcoal which adsorbs the remaining impurities.

Demand for helium is increasing at such a rapid rate that experts estimate our known helium reserves will last only 20 to 30 years. Early this year M. J. Ankeny, Director of the U. S. Bureau of Mines, testified before a Congressional committee that "the growing helium deficit is most serious when you consider that the fastest-growing helium requirements are in the area so vital to national degense and economy, particularly those of guided missiles and nuclear energy." In an effort to conserve critically needed supplies of helium, the Department of the Interior readied a program which would recover and store 3 million cubic feet of the gas per year. Under this plan private capital-- to the tune of $200-$300 million would be permitted to build 12 helium recovery and purification plants in the Amarillo area. Meanwhile, private industry is already moving to recover appreciable volumes of the billions of cubic feet of helium annually lost in the natural gas sent to industrial centers throughout the country. The Northern Natural Gas Company of Omaha and Air Products, Inc. of Allentown, Pa., recently formed a joint concern known as Helex Company to recover helium from natural gas. This firm is building a $13.5 million plant near Sunray, Texas, which is designed to yield approximately 260 million cubic feet of helium a year--roughly half of our total current production. Another encouraging note in the helium supply picture is the recent announcement by American Metal Products of Detroit that it has developed a process for recovering helium of high purity. The method consists in passing used helium through filters which remove droplets of moisture, carbon dioxide and any hydrogen. Remaining impurities such as oxygen and nitrogen are then reacted over a catalyst to render them readily separable from the helium. By this treatment the company claims it can produce helium containing less than 10 parts per million total impurities. While we are catching up in helium production facilities "Mr. Helium" doubtless wonders what new uses are still in store for this once useless--and now vital--gas.